



City of Tucson Residential Green Building Rating System

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This version for use within the:

City of Tucson Green Building Program

City of Tucson
Development Services Department
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Prologue

Local Context

While national standards for residential green building have been available for some time (LEED for Homes, NAHB National Green Building Program, etc.), none completely captures the particulars of our local Sonoran desert environment primarily due to lack of regional amendment components. Hence, the same standard applies to the northeast as to the southwest. In response to this concern, community stakeholders have participated in public meetings under the auspices of the Green Building Subcommittee of the Joint County/City Building Code Committee for a period of almost two years. These efforts produced an initial draft amended version of the original NAHB Model Green Home Building Guidelines.

In order to validate the locally amended draft, a study was undertaken comparing it to LEED for Homes, NAHB Model Green Home Building Guidelines (unamended), and the City of Scottsdale rating system through evaluating five house designs of differing levels of “greenness” sited in several theoretical locations across the City and County. This unique study, published in *Environmental Design & Construction*, has shed light upon the merits of each rating system, exposing the deficiencies in each and facilitating the further refinement of our local standard through revealing missed elements within the first draft, as well as capturing the best of national standards.

The City of Tucson undertook an analysis of the first version of the Pima County Regional Residential Green Building System in comparison to LEED for Homes and the NAHB Green Building Standard. This study confirmed the validity and rigorosity of the Pima County Regional Residential Green Building Program.

The green building element most prominent within the local context is water conservation, and from water conservation flows energy conservation since thermo-electric generation consumes 0.75 gallon of water for every kWh of electricity generated—this amount of energy is equivalent to a single 100 Watt bulb burning for 10 hours. For the average Tucson house, electrical consumption is the second largest user of water after outdoor uses. Hence reducing thermo-electric generated energy consumption saves water. This local standard has thus placed more emphasis in areas pertaining to water and energy.

Other elements incorporated within this standard are derived from the local climate which includes large diurnal temperature swings as well as hot dry conditions with ample sunshine. One such element is passive mass wall design which may even incorporate indigenous structural materials such as adobe and rammed earth.

Finally, biases present in national standards derived from serving specific industries were removed. Examples of these are low-VOC paints or green carpeting which while these are appropriately awarded points in national standards, the even more environmentally friendly approach of not using any of these materials is not. This standard therefore awards points for using exposed structural surfaces comprising the finish material such as concrete slabs and masonry walls.

This regional rating system is a living document, slated to be amended by all participating jurisdictions every six months.

Intent

Until the last century, the location of a family home or a community was reliant almost exclusively on its proximity to natural resources. Most settlement occurred only in areas with enough surface water, viable cropland, and raw building materials to sustain its inhabitants. Those regions with an abundance of resources could prosper by providing surplus commodities to nearby communities lacking one or more necessities but importation over long distances was impractical or impossible, especially when the imported goods were fragile, perishable, large, or heavy. The need to import scarce but necessary resources presented significant obstacles to community development. A delicate balance of growth was maintained by climate, and the availability of water, food, housing, and employment.

In the last one hundred years, the abundance of cheap fossil fuels, imported materials, and organized transportation networks completely reshaped the way we site and build our structures. These shifts also made it possible for human beings to inhabit regions—such as the Sonoran Desert—year round in relative comfort. These advances were not without negative effects. Most modern houses require large inputs of fossil fuels for heating and cooling interior spaces and for providing lighting, refrigeration, cooking, water heating, and maintaining remote power for electronic equipment. Over 39% of the total energy used in the United States is used for the operation of buildings, and much more is used in ways indirectly related to building location and design—especially traveling to and from the buildings we construct.

Building impacts are not just limited to energy use. Significant water consumption occurs in our homes through bathing, clothes washing, dishwashing, cooking, private swimming pools, and irrigation of private yards and gardens. Much of our water resources are wasted from unattended leaks, inefficient appliances, poor design in hot water delivery systems, and wasteful practices by users. Outdoor water use for landscaping in our region is estimated to account for 45% of overall water use in homes. By harvesting rainwater and incorporating native, drought-tolerant plantings outside residences, lush vegetation can be supported using only the rain that falls naturally on most sites.

In addition to increases in energy and water use, modern residences are often constructed from materials with a high embodied or transport energy. Materials extracted from distant regions require high energy inputs as they move from the harvest site to manufacturing facility to sales location to final construction destination. The large scale extraction of these materials often results in the degradation of habitat, while unregulated manufacturing practices introduce toxins into the environment. Transporting these materials across the globe consumes limited fossil energy resources and produces polluting emissions and greenhouse gases.

Of all human activities, the decisions we make in the design and construction of the built environment have perhaps the most significant impact on our natural surroundings, our social structure, and the long term economic viability of a community. The siting and design of a community can dictate whether its inhabitants will walk, drive, or use public transportation to get to work and to needed services; and even whether those sources of employment and services will flourish or struggle. Our building choices also reflect the value the community places on open space and preservation of the natural environment, and whether construction development will damage, coexist with, or enhance those attributes. Most importantly, the built environment is also the location of much of our energy, water and material consumption. “Green” building is the term used to describe the movement towards designing, building and operating structures that provide comfortable, durable, healthful living spaces, while minimizing resultant consumption of non-renewable resources, community disconnectedness and environmental degradation. Green Building has moved from a theory to a widespread practice in the last several years. This progress has been accompanied by strides in energy efficiency, cost control, and perhaps most importantly, a recognition that buildings—places within which we spend 90% of our life—have a dramatic impact on health of the natural environment, economy, public health and social fabric of our region.



City of Tucson

Residential Green Building Rating System

Introduction

The City of Tucson Residential Green Building Rating System is a voluntary system used by participating jurisdictions to guide builders, developers and owners in the design and construction of energy efficient, water-conserving, healthful homes. The rating system requires measurement and verification that the residence meets the minimum levels in each category. Single family, duplex, and triplex homes no more than three stories in height may apply for certification.

The rating system provides four levels of certification:

- Bronze Certification: 75-100 points
- Silver Certification: 101-130 points
- Gold Certification: 131-160 points
- Emerald Certification: Over 160 points

Home builders desiring to certify a new home should read the Rating System credit criteria and checklist to assess the design of their project. An initial orientation meeting with green building staff to review is strongly suggested to identify any special conditions or issues associated with the project. Once the residence is entered into the Green Building Program, it will be tracked through the permitting and inspection process for credits.

Builders must satisfy all mandatory requirements listed in for each category and submit appropriate documentation as noted to achieve certification. Final certification will be awarded upon issuance of the Certificate of Occupancy for the residence. Certification confers the right for the builder/owner to advertise the home as a Green Building Program Certified home at the level of certification attained.

Sizing Adjustment:

For every 200 square feet *less than 2300* square feet of floor area, *add one point*; for every 200 square feet *over 2800* square feet of floor area, *deduct one point*. Homes that fall within the 2300-2800 square feet neutral zone do not add or subtract points. Square footage shall be based on only conditioned space, and therefore does not include porches or unconditioned garages.

Building size, materials use, and energy consumption are interdependent. Research indicates that for every doubling of house size there is a corresponding 15-50% increase in energy use and a 40-90% increase in materials use. The City of Tucson Residential Green Building Rating System pegs neutral sizing to the area average of 2300 square feet. House designs that significantly deviate from the average, gain or lose points accordingly. Larger than average homes may need to include additional energy efficiency measures or innovation strategies to achieve certification.

For houses built to local jurisdiction 'affordable housing' criteria increase the House Size Adjustment by 1 point.

Section 1: Location, Lot Design, Preparation & Development

Minimum Required Points: 8

Community Criteria

MANDATORY: Incorporate the Native Plant Preservation requirements into the Landscape Plan as required. An approved Native Plant Preservation Plan is required before a Landscape Plan can be approved. The Native Plant Preservation Ordinance (NPPO) requires that a plan be submitted whenever the area of grading for a project is at or exceeds 14,000 square feet and the total lot area is 36,000 square feet or greater, or when the subdivision plat requires it.

Credit 1.1a: Build on a site outside of the Pima County Conservation Lands System. (2 points)

The Pima County Conservation Lands System (CLS) provides guidelines to ensure the conservation goals of the Sonoran Desert Conservation Plan (SDCP) are met. Lands within the CLS have important characteristics including wildlife habitat, riparian areas, species management areas, and scientific research areas. A certain percentage of the total lands within these areas must be preserved as open space. For more information on the CLS, follow this link:

<http://www.pimaxpress.com/Planning/Conservation/PlanAmendCLS.htm>

Credit 1.1b: Build on a site within the 'Downtown Infill Incentive District'. (2 points)
See: <http://www.tucsonaz.gov/planning/maps/city/infillincentivedistmaterial.pdf>

Credit 1.2a: Exceed the open space requirements for the parcel by 50%. (2 points)

Credit 1.2b: Develop at a density that is at least 75% of the maximum density for the site's zoning. (2 points)

Credit 1.2c: Develop at a density that is at least 100% of the maximum density for the site's zoning. (1 additional point)

For PAD zoning, the zoning immediately prior to the adoption of the PAD is used.

Credit 1.3: Build on a previously developed site. Previously developed sites include greyfields (previously paved areas), areas of existing construction or areas where a minimum of 75% of the site was previously developed for uses other than agricultural purposes, parks, or athletic fields. (2 points)

For more information on greyfield development, see:

<http://mayors.org/brownfields/library/greyfieldstogoldfields.pdf>

Credit 1.4: Select an infill site, such that 50% of the perimeter of the new development site borders existing development. (2 points)

Credit 1.5: Select a site within ¼ mile radius of a public transit stop, shared use bicycle/pedestrian path or lower speed signed bike route. (1 point)

Area separated bike/pedestrian paths and low speed bike routes are marked in yellow or green on the Tucson Metro Bike Map:

<http://dot.tucsonaz.gov/bicycle/pdfs/PAGBikeMap806.pdf>

Credit 1.6.a: Select a site within ¼ mile of at least four community services (1 point) OR

Credit 1.6.b: within ½ mile of eight community services. (2 points)

Community services include public schools, community centers, libraries, shopping centers, grocery stores, banks, hospitals/health clinics, restaurants, parks/playgrounds, community garden plots, child care centers, public swimming pools, farmer's markets, museums, performance centers (indoor or outdoor), theaters, or municipal services buildings.

Credit 1.7: Develop on a lot w/existing municipal sewer & water services. (1 points)

Credit 1.8: Prepare an operations and maintenance manual outlining ongoing service and care of common open space, retention/detention basins, wildlife corridors, and environmental management areas. (1 point)

Note: this manual shall be prepared specifically to address habitat and environmental maintenance issues of the site and its surroundings. If the residence is located in a subdivision with drainage improvements, the manual shall outline any periodic maintenance associated with these structures. It may also outline details of the Homeowner's Association common and open space. Homeowner equipment, operations and maintenance materials should not be included in this manual; they are addressed under Credit 6.1

Credit 1.9: Construct the residence on a site in a development that has successfully obtained any of the following distinctions: (4 points, only one certification can count towards point total):

- a. LEED-Neighborhood Development™ www.usgbc.org/leed/nd/
- b. Enterprise Green Community™ <http://www.greencommunitiesonline.org>
- c. Within Planned Unit Development designated by the jurisdiction as sustainable, such as the Civano PAD.

Note: The LEED-Neighborhood Development and National Green Building Standard are still in the preliminary or pilot stage, but projects that can demonstrate they meet the most recently drafted requirements of these programs will receive the credit. Although some overlap occurs between the requirements of the programs above and the City of Tucson Residential Green Building Rating System Program, the integration of homes that meet the criteria of the PCGBP into larger green developments enhances the sustainable aspects of these neighborhoods and provides examples of regionally appropriate green construction practices.

Individual Site Development & Amenities

Mandatory: Control and direct runoff with straw bales, silt fencing, silt sacks, rock filters or other approved devices. Stabilize soils on slopes over 10% with erosion control blankets or other approved methods. Slopes over 15% require documentation of best management practices to control erosion during construction and on the completed site. Credit 1.10: Minimize disturbed/compacted area of site to 15 feet around the perimeter of the building footprint, and one driveway access area no wider than 15 feet. The limits of clearing and grading shall be clearly demarcated on the Site Plan, and the "No Disturbance" boundary shall be flagged or fenced on site. (2 points)

Credit 1.11: Provide a grading plan showing balanced cut and fill, maintaining original topography. (1 point)

Credit 1.12: Protect and maintain on-site native vegetation for a minimum of 75% of the "No Disturbance" area. Protection and maintenance may include watering, and mulching. (1 point)

Credit 1.13: Appropriate landscape plantings for Pima County:

- a: Use only drought-tolerant, low-water use plants for landscaping plantings **OR**
If a rainwater harvesting system meeting the sizing requirements of Credit 4.1, 4.2 or 4.3 is installed, a combination of drought-tolerant plantings *and* food producing vegetation may be used. (2 points for either option)
- b: Use only native plants for landscaping. (1 additional point)

*Note: A list of low-water use plants appropriate for Pima County is available at:
www.azwater.gov*

Credit 1.14: Collect, conserve and protect topsoil on site for reuse. (1 point)

Credit 1.15: Install light colored, high albedo materials (minimum reflectance of 0.3) for:

- a: at least 50% of the site's hardscape (does not include roof) (2 points)
- b: 100% of the site's hardscape (does not include roof) (2 additional points)

Credit 1.16: Provide low water use vegetative shading for 25% or more of paved area/hardscapes. Vegetation must mature to provide this percentage of shading within 5 years. (2 points)

Credit 1.17: Prepare and implement a pest management plan that eliminates chemical pesticides including termite pretreatment. (1 point)

Subterranean termite control methods include physical barriers, such as metal or plastic sheeting or collars specifically designed for termite prevention, shall be installed in a manner to prevent termites from entering the structure. Shields placed on top of an exterior foundation wall are permitted to be used only if in combination with another method of protection. (see 2006 International Residential Code R320.4)

Credit 1.18: Fertilize all new landscaping with slow-release 100% organic fertilizer. (1 point)

Credit 1.19: Provide a stormwater diversion/recharge plan using gabions, rain gardens, grading contours and other acceptable measures for a minimum of 50% of the landscaped area to enhance recharge and utilize rainwater for landscaping. (1 point)

Innovation Credits

Innovation Credits are awarded in this category for measures that provide exemplary protection of the natural features and resources found on the site, implement creative solutions to mitigate detrimental effects of development on the natural environment, including those that promote open space, mixed-use development, increased density, preservation of significant site features, transportation alternatives, and community amenities. Requests for innovation credits may be submitted to the Green Building Program Manager for consideration. Innovation credits do not count toward the minimum points required in this category.

Note: See the Water Efficiency Section for related criteria.

Section 2: Resource Efficiency

Minimum Required Points: 10

Building Assembly

Credit 2.1: Advanced framing techniques:

- a: Use wood sheathing for shear walls only at locations required in the prescriptive portion of the currently adopted International Residential Code. (0.5 point) **OR**
- b.: Use an alternative to wood sheathing for shear walls (entire building). (1 point)
- c: Space joists at greater than 16" o.c. (0.5 point)
- d.: Use stack-framing at joists and single top plates. (0.5 point)
- e.: Space studs at greater than 16" o.c. (0.5 point)
- f.: Construct 2-stud corners. (0.5 point)
- g.: Construct insulated headers or box headers. (0.5 point)

Advanced framing techniques can save up to 20% of the lumber used in a residential project with no reduction in structural integrity. In order to claim these credits, applicants should submit a complete set of framing plans with all header sizes. For more information, see: <http://www.nahbrc.org/greenguidelines/advancedframing.pdf> or <http://www.toolbase.org/PDF/DesignGuides/advancedwallframing1.pdf>

Credit 2.2: Advanced wall and roof building systems:

- a: Use Structurally Insulated Panels (SIPs) for all appropriate exterior wall components. (2 points) **OR**
- b: Use an Insulated Concrete Form (ICF) or block system (i.e., Rastra, Mikey Block) for all appropriate exterior wall components. (2 points) **OR**
- c. Use Integra with R-26 minimum insulation or masonry/insulated equivalent for all appropriate exterior wall components. (2 points)
- d: Use Structurally Insulated Panels (SIPs) for all appropriate exterior roof components. (3 points)

Credit 2.3: Alternative material assemblies: Use rammed earth, adobe, strawbale, or natural building material for all *appropriate* wall components of the building. (4 points)

Environmentally Preferable Products

Credit 2.4: Use Environmentally Preferable Products for minimum of 90% of individual building components: (0.5 point per component, 8 points maximum)

Environmentally Preferable Products include materials with:

- Recycled content (25% minimum; i.e. steel roofing)
- Salvaged materials (i.e. doors, flooring)
- Rapidly renewable materials (i.e bamboo, wheatgrass)
- FSC certified wood
- Low VOC finishes
- Low VOC sealants

Individual Building Components:

Exterior Components

Foundation Aggregate
Foundation Structure
Wall Structure
Wall Siding or Masonry Veneer
Wall Sheathing
Roofing
Roof Structure
Sealants
Applied Finishes
Landscape Structures

Interior Components

Floor Framing
Wall, Ceilings and Millwork Finishes
Wall and Ceiling sheathing
Wall Framing
Flooring
Millwork
Trim
Counters
Doors (excluding Garage Doors)
Sealants
Applied Finishes

Credit 2.5: Additional points for use of Environmentally Preferable Products:

- a. No carpeting used in the residence. (1 point)
- b. Use structural or base materials as finish with no added paint or coatings. (1 point)

Examples of certification programs include Green Seal that works with manufacturers, industry sectors, purchasing groups, and governments at all levels to "green" the production and purchasing chain. We utilize a life-cycle approach, which means we evaluate a product or service beginning with material extraction, continuing with manufacturing and use, and ending with recycling www.greenseal.org

Also programs include the Carpet & Rug Institutes Green Label Plus certification OR SCS Sustainable Choice Certification.

Materials that meet the certification requirements of the programs above but have not officially obtained certification may be submitted for credit with the proper documentation showing compliance.

Credit 2.6: All wall and ceiling cavity/continuous insulation is: (choose one)

- a. A bio-based foam product (i.e. soy). (1.5 points)
- b. Recycled material (i.e. cotton, denim, cellulose). (1.5 points)
- c. Formaldehyde-free (Fiberglass or other materials acceptable). (0.5 point)

Credit 2.7: All wood beams, joists and rafters are made from engineered wood products. (1 point)

Credit 2.8: All trusses are engineered and use 2 x 4 or lesser diameter lumber for all truss members (0.5 point)

Unlike sawn lumber, engineered wood products utilize smaller trees, lower quality wood, and wood waste to produce structurally stable, strong building components. See www.apawood.org for more information.

Credit 2.9: Use sustainably grown and harvested wood:

- a. All structural wood used in residence is FSC (Forest Stewardship Council) Certified Wood. (1 point)
- b. All wood (interior and exterior, including trim) is FSC Certified Wood. (1 additional point)
- c. All FSC wood in 2.9a or 2.9b is from an FSC Certified Forest located in Arizona. (1.0 additional point)

The Forest Stewardship Council monitors and certifies lumber to standards for forest sustainability and stewardship. FSC certified wood is available from major retail building supply outlets. For more information see www.fscus.org

Credit 2.10: All installed cabinetry and built-ins are made from materials that contain no added urea-formaldehyde resins. (1 point)

Credit 2.11: Use an HVAC system that does not use refrigerants or uses non-HCFC refrigerants. (1 point)

The R22 refrigerant that has been typically used in air conditioning systems contributes to the depletion of the earth's protective ozone layer. Non HCFC refrigerants include R410a.

Credit 2.12: Provide an area for recycling with bins inside the house. (1 point)

Credit 2.13: A minimum of 18% of the concrete content of the building is replaced with fly ash or slag. (1 point)

Regionally Extracted and Manufactured Products

Credit 2.14: Regionally extracted and harvested materials: See Credit 2.4 for list of building components

- a: 75% of a building component is extracted and manufactured from within a 500 mile radius of the building site. (0.5 point per component; 4 points max.)
- b: 75% of a building component is extracted and manufactured within Arizona. (0.5 additional points per component; 2 points max.)
- c: For projects involving new pathways, driveways or sidewalks, use exterior paving materials from within a 100-mile radius of the building site. (1 point)

Regionally extracted and manufactured materials use less fossil fuel for transport and support the local economy. Builder shall document that the material was harvested and processed within the specified radius of the building site..

Construction Waste Management

Credit 2.15: Reduce construction waste based on industry average:

- a: Reduce construction waste to 25% less than industry average. (3 points);
- b: Reduce construction waste to 50% less than industry average. (3 additional points);
- c: Reduce construction waste to 75% less than industry average. (3 additional points).

Data from the National Association of Home Builders Research Center indicates the industry averages 4.2 lbs (0.0265cubic yards) of waste per square foot of conditioned space. To achieve this credit, multiply the conditioned space square footage by 4.2 to get the average waste for the size of the residence. A Construction Waste Management calculator is available on our web site. Demonstrate a minimum 25% reduction through submittal of a waste management plan documenting the amount of waste diverted through reduction, recycling, reuse, salvage or donation of excess materials to a non-profit organization. Land clearing waste and demolition waste from removal of pre-existing structures does not count towards the totals.

Section 3: Energy Efficiency

Building Design & Orientation

Minimum Required Points: 14

Passive Solar Design can help reduce heating loads and minimize interior temperature swings. Credits 1-3 below address passive solar building form and orientation.

Basic design principles: the building's south face should receive sunlight between the hours of 8:00 A.M. and 12:00 P.M. (sun time) during the heating season. Sunlight entering the building should strike floor and/or wall materials with a high thermal mass, such as masonry, adobe, rammed earth or tile. It is important to note that improper passive solar design may result in overheating that can actually increase energy consumption. Strongly consider consulting a designer with experience in passive solar buildings to do an analysis of the residence prior to construction. See: <http://www.azsolarcenter.com/design/pas-1.html> for additional information.

Credit 3.1: Provide permanent shading devices or overhangs for all south-facing fenestration such that the fenestration is fully shaded between 11 a.m. and 1 p.m. during the months of June, July and August. (2 points)

For proper overhang sizing information see: <http://www.azsolarcenter.com/design/pas-3.html>

Credit 3.2: Use proper amount and type of glazing to maximize appropriate solar gain:

- a: Design the building to be a rectangle. Orient the building so the longest side faces within 30 degrees of true south and locate less than 20% of total glazing on the east and west faces of the building. (4 points)
- b: If attempting Credits 3.1 and 3.2, install appropriate glazing type for each orientation. (2 additional points)

For information on appropriate glazing types for passive solar heating see: <http://www.nrel.gov/docs/fy01osti/27954.pdf>

- c. Provide hourly computer simulation documentation proving that a minimum of 75% of the space heating load is met by passive solar design of the building envelope. (6 points)

Typical hourly (365days x 24 hours) computer energy modeling software includes: Energy-10, CalPas3 and EQuest.

Credit 3.3: Plant drought-tolerant trees (preferably native), minimum 5 gallon sapling, on the east or west side of the residence as close to the residence as possible without causing future root damage to structure. Trees must have a minimum mature height of 15 feet and cast shade on the east or west walls to provide measurable benefits during the cooling season. (1 point per tree; max. 3 points)

Remember to integrate your landscaping design with future plans for active solar, such as PV panels, so as not to shade areas designated for future solar collection. Planting deciduous trees on the south side and evergreen trees on the east, west and south will provide the greatest energy savings.

See: <http://www.epa.gov/heatisland/strategies/vegetation.html> for additional information on shade trees and their associated energy saving benefits.

Credit 3.4: Construct a passive evaporative cooltower for internal building cooling. (2 points)

For more information on passive evaporative cooltower design, see:
<http://cala.arizona.edu/research/hed/publications/ASES97/Ases97.html>

Credit 3.5: Design and construct an exhaust (convection) tower, solar chimney, or below grade cooling tube system. (3 points)

The following link provides additional resources on the design and construction of exhaust towers and other passive solar structures:
<http://www.azsolarcenter.com/design/passive-3.html>

Credit 3.6: Design and construct a vestibule or foyer at the main entrance of the residence that provides an enclosed, passively ventilated transitional space between the outdoors and the interior of the building. (1 point)

Credit 3.7: Install interior window treatments such as “solar shades” or similar products:

- a: with an openness factor of 8% or less on 50% of all east, west and south facing windows. (1 point) **OR**
- b: 100% of all east, west and south facing windows. (1 additional point)

Openness Factor" - (O.F.) Refers to the ratio of open area to the total flat surface area of a drapery fabric or perforated material. This quantity relates well to the amount of solar heat admitted through a fabric or perforated material to the extent to which discomfort results to individuals near the glazing system.

Credit 3.8: Install ENERGY STAR rated appliances. (1 point/appliance type; max. 4 points)

- a: Refrigerator
- b: Dishwasher
- c: Clothes Washer
- d: Freezer

Credit 3.9: Install a whole house ventilation system/economizer to ventilate residence with outside air. (2 points)

Credit 3.10: Install lighting and ceiling fans in accordance with the ENERGY STAR Advanced Lighting Package (ALP) criteria. (1 point)
http://www.energystar.gov/index.cfm?c=fixtures.alp_consumers

Credit 3.11: Install tubular skylights for illumination of interior spaces. (0.5 point per skylight, max. 2 points.)

Credit 3.12: Provide a minimum 15' retractable or fixed outdoor clothesline or an installed drying rack in the laundry room for each dwelling unit. (1 point)

Credit 3.13: Install a Heat Recovery Ventilation (HRV) or an Energy Recovery Ventilation (ERV) system to condition incoming outside air. (2 points)

Credit 3.14: Install a passive solar ventilation air preheating system. (1 point)

For additional information on passive solar air preheating systems:
<http://www.toolbase.org/TechInventory/techDetails.aspx?ContentDetailID=773>

Credit 3.15: Insulate all hot water lines to a minimum of R-4 throughout entire residence. (1 point)

Credit 3.16: Provide two ½ inch plumbing line stub outs from the water heater area to a south facing roof for future solar thermal installation. This will be code requirement by the City of Tucson after June 1, 2010 This credit may be taken with Credit 3.17. (1 point)

Credit 3.17: Install a solar thermal hot water system:

- a: To provide a minimum of 60% of the estimated annual load (the “Solar Fraction”). (2 points) **OR**
- b: To provide 90% of the estimated annual load. (3 points)

Credit 3.18: Provide electrical conduit from service panel to flat or south-sloping roof surface area for future solar PV system. (1 point)

Credit 3.19: Install a solar PV system (grid tied or off grid) to generate on-site electricity. (1 point for each 10% of annual electrical load)

Credit 3.20: Control bathroom exhaust fan with a humidistat or timer. (0.25 points per installed controller; 0.75 points maximum)

Humidity control in bathrooms is a durability issue yet uncontrolled exhaust of conditioned air wastes energy.

NOTE: Applicants should choose between a Performance Path, a Program Path and a Prescriptive Path for most energy efficiency measures. If taking a Performance Path or Program Path approach, credits cannot be taken for Prescriptive measures.

Performance vs. Program vs. Prescriptive Path: Remember that only one path can be used for scoring a residence. There are several existing residential energy efficiency rating programs in the region that provide prescriptive guidance on insulation installation, building shell assemblies, heating/cooling equipment efficiencies, and air leakage. To provide flexibility, builders may opt to use a Program Path with one of the existing rating programs as a basis for credits, or a Performance path in which the builder submits Home Energy Rating System (HERS) rating documentation demonstrating the energy performance of the residence. The Prescriptive Path may be used if the builder chooses only to use individual measures, exceeding the Prescriptive guidelines found in the International Energy Conservation Code (IECC). In order to obtain maximum points, the Prescriptive path is not recommended if the residence can obtain points through the Program or Performance paths.

The performance path may be a better choice for those builders not seeking utility company guarantees or alternative construction that does not utilize components such as air barriers and typical HVAC units to achieve energy performance. The performance path may also be appropriate for innovative technologies that are not addressed adequately in the prescriptive path of the rating system.

For more information on the HERS rating system follow this link:

http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_HERS

Performance Path:

Minimum Required Points: 25

Mandatory: Meet the requirements of the currently adopted International Energy Conservation Code.

Mandatory: Provide documentation of third-party testing for residential energy performance by a certified HERS rater (Home Energy Rating System).

PERF 1: Exceed the performance requirements of the currently adopted International Energy Conservation Code (IECC) by a minimum of 15% (25 points plus 2/3 points for each additional percent increase above 15%)

Formula: Points = 25 + (Percent exceeding IECC – 15) x 0.6667

Note that the IECC percent performance improvement = 100 – HERS rating.

OR

PERF 2: Design and construct a zero-net energy home. (82 points)

The HERS (Home Energy Rating System) is a relative energy use rating that compares the energy use of a residence on a numeric scale. HERS ratings are done by certified raters and have been used in the ENERGY STAR program, Energy Efficient Home Mortgage Program, and local utility company guarantee programs. For more information, see www.natresnet.org.

Energy Program Path:

Minimum Required Points: 25

PROG 1: Meet the requirements of the ENERGY STAR™ for Homes Program
<http://www.energystarhomes.com> (25 points)

OR

PROG 2: Meet the requirements of the Tucson Electric Guaranteed Home Program:
<http://tucsonelectric.com/home/GuaranteeHome> (25 points)

OR

PROG 3: Achieve EPA Act Home Certification.
<http://environmentallygreen.com/builder.aspx> (38 points)

***Note:** There is a \$2000 tax credit to builders for each EPA Act Certified home. See: <http://environmentallygreen.com/epact.aspx> for more information.*

Prescriptive Path Individual Measures

Minimum Required Points: 20

Mandatory: Size the HVAC system properly according to heating and cooling loads calculated using ACCA 556 (Manual J) or equivalent.

Mandatory: Size and install the duct system properly according to ACCA 29-D (Manual D) or equivalent.

Mandatory: Seal entire duct system with water-based mastic, tape or a non-toxic aerosol spray-applied duct sealant.

Mandatory: Install an ENERGY STAR rated programmable thermostat.

Mandatory: Install only ENERGY STAR rated bathroom exhaust fans.

Mandatory: Install only ENERGY STAR or equivalent rated windows and skylights throughout the residence.

ENERGY STAR rated windows are dual-pane, Low E coated glass with thermally broken panes, and have a maximum SHGC (Solar Heat Gain Coefficient) of 0.4 and, a maximum U-factor of .40. Skylights have a maximum SHGC of .40 and a maximum U-factor of .60. These features save energy by reducing heat flow and glare. See www.Energystar.gov

Mandatory: Seal off entire duct system during construction or clean all ducts and HVAC equipment following construction completion.

Mandatory: If radiant or hydronic space heating systems are utilized, the system shall be designed using Gas Appliance Manufacturer's Association GAMA-H-22 guidelines. See <http://www.gamanet.org>, Radiant Panel Association (RPA) Guidelines, www.radiantpanelassociation.org or by an accredited design professional in accordance with manufacturer's recommendations.

PRES 1: Insulation shall be installed to achieve “Grade 1” certification; regardless of the insulation material or installation process. (1 point); See <http://www.getenergysmart.org/Files/InsulationAssessment.doc>

PRES 2: Air leakage rate from the envelope no more than 0.5 ACH (air changes per hour) or .35 cfm/ft² of building enclosure area @ 50 Pa. (2 points)

OR

PRES 3: Air leakage rate from the envelope no more than 0.35 ACH (air changes per hour) or .25 cfm/ft² of building enclosure area @ 50 Pa. (4 points)

OR

PRES 4: Air leakage rate from the envelope shall be less than or equal to 0.25 ACH (air changes per hour) or .15 cfm/ft² of building enclosure area @ 50 Pa. (6 points);

PRES 5: Locate all ducts within conditioned building space. (1 point)

PRES 6: Install air handling systems, furnaces, and water heaters in conditioned space. (1 point);

PRES 7: Install an ENERGY STAR or Cool Roof Rating Council certified roofing system. (2 points) See http://www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products or <http://www.coolroofs.org>

PRES 8: Provide 1” (R-4) continuous rigid insulation on exterior of structural wall assembly. (1 point); *OR* Provide 2” (R-8) continuous rigid insulation on exterior of structural wall assembly. (2 additional points)

Continuous insulation on the exterior of stud or masonry walls greatly reduces air infiltration and thermal bridging through wall assemblies.

PRES 9: Use blown-in or foam insulation at:

- a. Walls (2 points)
- b. Ceilings (2 additional points);

PRES 10: Install “energy” trusses. (1.5 points)

Raised heel and oversized cantilevered trusses do not compress insulation at building eaves, allowing full effective depth of insulation. For examples see:

http://www.1800arkansas.com/business_development/energy/files/Clearinghouse/ACF789F.pdf

PRES 11: Install a water recirculating, high efficiency evaporative cooler, with timer ejector system. Released water shall be plumbed for landscape irrigation. (1 point)

OR

PRES 12: Cooling system is an electric heat pump with multi-speed compressor and variable speed air handling units. (2 points)

PRES 13: Cooling system is a hydronic radiant system or a ground-source heat pump. (3 points)

For information on hydronic radiant heat systems see:

For information on ground-source heat pumps see:

<http://www.toolbase.org/TechInventory/TechDetails.aspx?ContentDetailID=754&BuckID=6&CategoryID=6>

PRES 14: Insulate the attic access opening to the same value as the ceiling insulation; OR design for no internal attic access. (0.5 point)

PRES 15: Install a gas furnace with an efficiency rating of at least 90%; (1 point).

Section 4: Water Efficiency

Minimum Required Points: 15

Rainwater Harvesting

Credit 4.1: Install a rainwater harvesting system with a minimum catchment area = 500 sq. ft.:

- a. Capable of retaining and storing 10% of the average annual available rainfall on the catchments surface. (2 points) **OR**
- b. Capable of retaining and storing 25% of the average annual available rainfall on the catchments surface. (4 points) **OR**
- c. Capable of retaining and storing 50% of the average annual available rainfall on the catchments surface. (6 points)

Most rainwater harvesting systems include a catchment surface, gutters w/ filtered downspouts, underground or above ground storage tank, and drip irrigation system for disbursing the harvested water on the landscape as needed. Cisterns should be covered or screened to avoid breeding mosquitoes or contamination. Annual rainfall for Pima County varies from under 11 to over 14". For the purposes of estimation, an annual rainfall of 12.3" may be used. You may use the [rainwater harvesting calculator](#) to compute the size of the storage tank needed.

For more information on the design of rainwater harvesting systems:

<http://ag.arizona.edu/pubs/water/az1052/>

<http://www.harvestingrainwater.com>

The Arizona Department of Environmental Quality brochure on appropriate uses of greywater can be found at:

<http://www.azdeq.gov/environ/water/permits/download/graybro.pdf>

Credit 4.2: Install a gutter and downspout system or canals that tie to stormwater infiltration trenches, bioswales, or rain gardens (see references noted above for construction details). (0.5 point per downspout; max 2 points)

Greywater Reuse

Credit 4.3: Install separate greywater and sanitary sewer lines on residences with greywater lines stubbed out to exterior and clearly marked. This will be code requirement by the City of Tucson after June 1, 2010. (1 point)

Credit 4.4: Use of greywater: In addition to installing greywater lines per Credit 4.3:

- a. Install a separate supply line from the greywater stub out to each toilet (1 point per toilet, 3 points maximum)
- b. Connect the greywater lines to an appropriate distribution system serving landscaping. (2 additional points)
- c. Connect the greywater lines to an appropriate distribution system serving the toilets. (2 additional points)

For more information on the legal uses of greywater and best management practices in Arizona follow this link:

<http://www.azdeq.gov/environ/water/permits/download/graybro.pdf>

Greywater and Rainwater Harvesting Tax Credits in Arizona Effective January 1, 2007: Arizona taxpayers who install a "water conservation system" (defined as a system to collect rainwater or residential greywater) in their residence may take a one-

time tax credit of 25% of the cost of the system (up to a maximum of \$1,000). Builders are eligible for an income tax credit of up to \$200 per residence unit constructed with a water conservation system installed. At the moment only greywater-harvesting systems qualify for the credit, but State legislators are planning to remedy this in the near future so rainwater-harvesting systems will also qualify. For application forms and further information go to: www.azdor.gov click on "credit pre-certification" on the left hand side of the home page click on "gray water conservation tax credit." There is general information and applications for corporations and for individuals.

Plumbing, Appliances & Fixtures

Information on EPA WaterSense™ water-efficient products and programs may be found at: <http://www.epa.gov/watersense/index.htm>.

Credit 4.5: Install a "central-core" plumbing system with all water-using fixture fittings within five feet of the hot water heater. (1 point)

Credit 4.6: Install a manifold controlled "home run" water distribution system. Fixtures shall be located within 10 feet of the circulation loop with branch lines no greater than 0.5" in diameter. (2 points)

Credit 4.7: Install a manual or motion activated on-demand hot water circulation pumping system (note: continuous recirculation systems do not qualify). (2 points)

Credit 4.8: Install a point-of-use tankless hot water heater that uses only cold water supply or solar-assisted preheating for any fixture greater than 20 pipe run feet from water heater. (1 point per fixture; maximum 3 points)

Credit 4.9: Install lavatory faucets that meet the proposed EPA's WaterSense™ criteria or have a maximum flow rate of 1.5 gpm or less. (1 point each faucet, maximum 3 points)

Credit 4.10: Install showerheads that meet the proposed EPA's WaterSense™ criteria or have a maximum flow rate of 1.5 gpm @ 80 psi. (1 point per fixture; maximum 3 points)

Credit 4.11: Install water efficient toilets:

- a. Install High Efficiency Toilets (HET) that meet the EPA's WaterSense™ rating (1.28 gpf) (1 point per fixture; maximum 3 points)
- b. Install composting toilet(s). (2 points per fixture; no maximum)

Credit 4.12: Install a washing machine with a water factor of 6.0 or less. (2 points);

Credit 4.13: Install a refrigerator with an in-door filtered water system (0.5 point)

Credit 4.14: Install excess flow check valves or excess water shutoff connectors at fixtures. (0.5 point per fixture; maximum 3 points)

Credit 4.15: No swimming pool. (2 points)

Credit 4.16: No decorative water features or mister systems that use potable water (harvested rainwater is acceptable). (1 point)

Credit 4.17: No under sink garbage disposal systems. (1 point)

Impervious Surfaces

Mandatory: Design for impervious driveway and walkway surfaces equivalent to <10% of the total site area (less than 5 acres) OR <1% of the site area (over 5 acres); Note: Multi-family housing with greater than two units on a common lot are exempt from this requirement.

Mandatory: Wash out concrete trucks into storage containers, not on to soil.

Credit 4.18: Design for pervious driveway and walkway surfaces for 50% of site hardscape. (2 points)

Credit 4.19: Design for pervious driveway and walkway surfaces for 100% of site hardscape. (2 additional points)

Credit 4.20: Install a vegetative roof system that uses a non-potable water source over at least 50% of the total roofed area. (3 points)

Vegetative or "green roofs" can provide stormwater management, passive cooling, and additional useable outdoor space to a building. In hot, dry climates, care must be taken to ensure that plants species will not require additional water inputs beyond those that can be supplied through water harvesting (from rain or greywater) available at the site. For additional information follow this link: www.greenroofs.org

Irrigation Systems

Credit 4.21: Install landscaping designed by a licensed landscape professional using drought-tolerant plantings that require no irrigation. (3 points)

Credit 4.22: Irrigation system is designed and installed by an EPA Watersense™ certified landscaping professional. (1 point)

*For more information on EPA Watersense™ certification, follow this link:
<http://www.epa.gov/watersense/pp/irrprof.htm>*

Credit 4.23: Install a high efficiency irrigation system that includes the following items (0.5 point for each item below):

- a: "Smart Controllers" with moisture sensors, rain delay controllers, and high efficiency nozzles.
- b: Check valves in heads and heads matched to the beds distinct watering needs;
- c: Separate sprinkler zones for beds, with plants grouped based on watering needs (hydrozoning).
- d: A timer/controller that irrigates during the hours of 10 pm to 8 am to minimize losses from evaporation.
- e: Drip irrigation for all planting beds.

Section 5: Indoor Environmental Quality

Minimum Required Points: 4

Credit 5.1: Garage:

- a: Garage is detached from residence. (1 point) **OR**
- b: No garage is constructed. (2 points)

Credit 5.2: Complete the requirements for the EPA's ENERGY STAR Indoor Air Quality Package certification. (3 points)

For additional information see:

http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_iap

Credit 5.3: Garage is provided with a 100 cfm exhaust fan with operation controlled by an occupant sensor, garage door opening/closing device, or timer. Provide outside make-up air through a screened inlet. (1 point);

If credit 5.1.b is taken, no credits can be claimed for Credit 5.3.

Credit 5.4: Test for radon and if the radon level is 2 pCi/L (pico Curies per Liter) or more, install a radon ventilation system, or other recommended system, and seal cracks and holes in foundation/slab. (1 point);

See <http://www.epa.gov/radon/index.html> for more information on radon, testing, and methods of abatement.

Credit 5.5: Natural gas appliances:

- a. Install only combustion sealed gas furnaces, fireplaces and water heaters in the residence. (0.5 point per fixture, 2 points maximum) **OR**
- b. Provide an airtight area, directly ventilated to the exterior, designated for gas furnace and/or gas hot water heater installation. A utility closet with a sealed door and all equipment vented to the outside qualifies for this credit. (1 point)

Credit 5.6: Install a whole house filtration system with a disposable filter MERV rating of at least 11 or an electrostatic filter rating of 95% arrestance at .1 micron. (1 point);

A MERV (Minimum Efficiency Reporting Value) rating is a furnace filter rating that describes the filter's ability to trap particles such as dust and pollen. Filters with higher MERV ratings are more effective in capturing particulates, but these filters must be changed on a regular basis, or they become clogged and reduce furnace efficiency. For more information on MERV ratings see: <http://www.furnacefiltercare.com/merv-ratings.php>

Credit 5.7: Vent remote exhaust systems in kitchens and bathrooms directly to the outside. (0.5 point per fan max. 2 points)

Credit 5.8: Clean all ducts, and perform a post-construction, pre-occupancy flush by keeping windows open and the HVAC system fan running continuously for a minimum of one week. Replace air filter upon completion of flushing period. (1 point)

Credit 5.9: Install a central vacuum cleaner system in the residence. (1 point)

Central vacuum cleaner systems vent to the outdoors, preventing the return of particles into the home through the exhaust vent found in standard vacuum cleaners.

Credit 5.10: Do not install a fireplace in the residence. (1 point).

Section 6: Operation, Maintenance, & Owner Education

Minimum Required Points: 2

Homeowner Education & Maintenance

Credit 6.1: Provide an informational package to homeowners at closing, including a description of all features and systems, maintenance manual describing and illustrating the care and maintenance the homeowner should perform on all features and systems to keep them operating properly, a list of service providers/equipment suppliers for all features, and any other appropriate materials for the construction and system type. The manual shall also outline ongoing service and care of common open space, retention/detention basins, wildlife corridors, and environmental management areas as appropriate. (2 points)

Credit 6.2: In addition to the manual above, commission all systems by performing a system start up, verifying system operating performance, and simulating failure/back up modes. Document the results of the commissioning, adjustments made, and ongoing issues requiring additional maintenance or adjustment. Submit documentation to owner. (2 points)

Section 7: Innovation Points

Minimum Required Points: 0

Innovation Points

The field of green building and sustainable residential design continues to evolve as experience and insight into the best possible practices for delivering high quality green products increases. The City of Tucson Residential Green Building Rating System encourages applicants to pursue credit for noteworthy achievements in performance; design and construction (Please note that innovation is not limited by prescriptive code application since applicants may pursue building code alternative compliance through the ICC Performance Code for Buildings and Facilities). Innovation points are available in every category for green building measures and methods that result in superior performance, efficiency, cost reduction or environmental benefits. Points are awarded based on the individual measure's difficulty of implementation and level of impact, and typically range from 0.5 to 5 points.

